

Educational Efficiency of Higher Normal Universities in China

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Abstract—In recent years, undergraduate education in higher normal universities in China has actively adjusted the discipline and professional setting for today's talent market, and has continuously invested a lot of manpower, financial and material resources to expand educational production. However, some problems like unreasonable structure of education input, low utilization rate are existing in this process. From the angle of educational efficiency, this paper uses the models of DEA efficiency evaluation to empirically analyze the undergraduate education efficiency of 31 higher normal universities in China, and gives the improvement on the input and output of DEA ineffective higher normal universities, finally analyzing the sensitivity of indicators to identify the key factor leading to the relative inefficiency of undergraduate education. This paper intends to provide reasonable suggestions for the improvement of undergraduate education efficiency in higher normal universities in order to promote the connotative development of undergraduate education in higher normal universities.

Keywords—higher normal universities, undergraduate education, educational efficiency, data envelopment analysis (DEA)

I. INTRODUCTION

The basic framework of higher normal universities in China is based on the higher teacher educational system of the former Soviet Union, and the initial professional setting is extremely concentrated. In a sharply changing society, the previous education mode of higher normal universities can no longer meet the needs of current talents training. Higher normal universities are transforming themselves from the normal universities to comprehensive universities by taking advantage of their unique disciplines and professional backgrounds.

Talent cultivation is the essential function of a university. Undergraduate education is the foundation of a university. Today, the process of the popularization of undergraduate education in China is deepening, and the demand of labor market is also diversified. The undergraduate education of higher normal universities in China is actively adjusting the discipline and professional setting to achieve comprehensive development. After years of development, Although the quality of undergraduate education in normal universities has been comprehensively improved, and school management has gradually got into the track of standardization and scientification, undergraduate education in higher normal universities has long taken an "extensive"

development path that blindly relies on increasing the investment of manpower, financial and material resources, and ignoring the importance of resource utilization and the reasonable structure of internal allocation, resulting in low economic benefits and social benefits.

Educational efficiency, i.e. the ratio of educational output to the input of educational resources, was first defined by James S. Coleman, et al. in the "Report on Equality of Educational Opportunities". Since educational efficiency has a positive influence on the effectiveness of schools' inputs and outputs, the study of educational efficiency has attracted more attention of scholars. However, most of the studies focus on the theoretical interpretation and framework construction about the inputs and outputs of higher education, and most of the scholars adopt appraisal methods of economy, including benefit-cost ratio method, net present value method, and regression analysis. The conditions of using these methods are relatively strict and there are many shortcomings in comprehensive evaluation. The higher educational system is a system with multiple inputs and outputs. The DEA method does not require to determine the functional relationship between the input and the output in advance, and does not require any weighting assumptions. Thus it has a unique advantage in educational evaluation. Considering the actual situation of undergraduate education in higher normal universities in China, this paper analyses performance of education systems by means of DEA approach, points out the improvement direction of the inputs and outputs of DEA ineffective higher normal universities, and identifies the key factor leading to the relative inefficiency of undergraduate education. We aim to provide useful suggestions for the improvement of undergraduate education efficiency in higher normal universities, and to promote the connotative development of undergraduate education.

II. THE INTRODUCTION OF DEA METHOD

DEA is a methodology defined by Charnes, et al. on the basis of the concept of relative efficiency evaluation. It is an effective method for evaluating the relative efficiency of the production or non-production departments, i.e. the decision making unit with the same type of inputs and outputs. This paper mainly adopts the CCR and BCC models of DEA.

Let n similar decision making units DMU_j ($j=1, 2, \dots, n$), the input and output vectors corresponding to DMU_j are:

$$\begin{aligned}
 X_j &= (x_{1j}, x_{2j}, \dots, x_{rj})^T \quad j=1, 2, \dots, n \\
 Y_j &= (y_{1j}, y_{2j}, \dots, y_{sj})^T \quad j=1, 2, \dots, n \\
 X_{rj} &> 0, Y_{sj} > 0
 \end{aligned}$$

A. CCR Model

In 1978, Charnes and Cooper proposed the first CCR model based on the constant returns to scale, that is, when the model evaluates the efficiency of a decision making unit, the assumption is that the scale benefits of production remains unchanged. The model is as follows:

$$(D_{CCR}) \begin{cases} \text{Min} \theta \\ \text{s.t.} \sum_{j=1}^n \lambda_j x_j + s^+ = \theta x_0 \\ \sum_{j=1}^n \lambda_j y_j - s^- = y_0 \\ \lambda_j \geq 0, j = 1, 2, \dots, n \\ \theta \text{ is unconstrained, } s^+ \geq 0, s^- \geq 0 \end{cases} \quad (1)$$

For the above CCR model, when $\theta^*=1$, the input relaxation variable S^+ and the output relaxation variable S^- are both equal to 0, the decision making unit is DEA efficient, and it is both technically effective and scale effective; when $\theta^*=1$, the input relaxation variable S^+ and the output relaxation variable S^- are not both equal to 0, then the DMU is weakly efficient, and the decision making unit has the problem of excessive input or insufficient output; when $\theta^* < 1$, the decision making unit is neither technically optimal nor scale optimal.

B. BCC Model

In order to deeply understand variable returns to scale of the DMU, the BCC model is taken into consideration in 1984 by Banker et al. The specific expression is as follows:

$$(D_{BCC}) \begin{cases} \text{Min} \theta \\ \text{s.t.} \sum_{j=1}^n \lambda_j x_j + s^+ = \theta x_0 \\ \sum_{j=1}^n \lambda_j y_j - s^- = y_0 \\ \sum_{j=1}^n \lambda_j = 1, j = 1, 2, \dots, n \\ \theta \text{ is unconstrained, } s^+ \geq 0, s^- \geq 0 \end{cases} \quad (2)$$

According to the BCC model, if $\theta^*=1$, the DMU is weakly efficient; if $\theta^*=1$, and $S^{*+}=0$, $S^{*-}=0$, then the decision making unit is DEA efficient.

III. EMPIRICAL ANALYSIS OF UNDERGRADUATE EDUCATION EFFICIENCY IN HIGHER NORMAL UNIVERSITIES

A. Construction of the Evaluation Index System

The reasonable construction of the evaluation index system helps to improve the quality of the efficiency evaluation work. The evaluation index system in related research is mainly divided into three aspects: manpower, financial and material input. Regarding manpower input, it mainly involves the quantity and quality of full-time teachers; about the financial input, it mainly includes the amount of scientific research funds and education expenditures; and the material input mainly focuses on fixed assets such as the equipment. Regarding the output factors, three functions of modern universities are generally recognized as talent cultivation, scientific research and social services. Therefore, most of the related research uses these three aspects as the standard to construct the output index system. Of course, final output indicators should be adjusted considering different research questions, available data and so on. Based on the previous research, this paper fully considers the rationality of the evaluation index system, the availability and objectivity of the data, then constructs the evaluation index system of the undergraduate education in China's higher normal universities, as shown in Table 1.

TABLE 1. THE EVALUATION INDEX SYSTEM OF UNDERGRADUATE EDUCATION EFFICIENCY IN NORMAL UNIVERSITIES

input index	X1	the number of full-time teachers (person)
	X2	the class ratio of associate and full professors for undergraduates
	X3	undergraduate students' teaching expenditure (yuan/person)
	X4	per capita teaching administrative room area (m ² / person)
	X5	total value of teaching and research equipment assets (ten thousand yuan)
output index	Y1	the number of undergraduate students (person)
	Y2	the rate of undergraduate graduates' further education
	Y3	the rate of degree award
	Y4	the employment rate of undergraduate graduates

As shown in the table above, the evaluation index system is composed of five input and four output indexes. About manpower input, the number of full-time teachers and the class ratio of associate and full professors for undergraduates are evaluation indicators, which fully consider the quantity and quality of teaching. About financial input, X3 is undergraduate students' teaching expenditure. Under the premise of indicators' availability, this paper defines the undergraduate students' teaching expenditure as the sum of the daily running expenses, the experimental funding, and the internship funding for undergraduate students. In regard to material input, X4 is the per capita teaching administrative room area, referring to the sum of teaching, research, auxiliary rooms and administrative office

buildings, then X5 is the total value of teaching and research equipment assets.

About the output index, considering talent cultivation, Y1 is the number of undergraduate students, and Y2 is the rate of undergraduate graduates' further education, including domestic enrollment rate, going abroad rate and exit rate. In the aspect of scientific research, considering that undergraduate talent cultivation focuses on the improvement of comprehensive quality, the research ability of undergraduates is relatively weak compared to graduate and doctoral students, besides their research fruits are few and it is difficult to collect fully and effectively. In this paper, Y3 is defined as the rate of degree award, and Y4 is defined as the employment rate of undergraduate graduates from the perspective of social services. The data of Y2-Y4 faces to 2017 undergraduate graduates.

B. Data Collection and the Correlation Analysis of Indexes

Considering that the selected sample should be representative, the educational efficiency of higher normal universities mainly faces to six normal universities owned directly by Ministry of Education and 35 provincial key normal universities. The input-output indicator data mainly comes from the provincial education departments and the "Report on the Quality of Undergraduate Teaching of 2016-2017", published by official websites. Due to the data of some higher normal universities is incomplete and cannot be collected fully or has singular values. After screening, this paper finally chooses 31 higher normal universities as research samples. It is generally considered that the number of evaluation units is not less than two to three times of the total number of input and output indicators, thus the number of samples can meet the requirement.

Before doing empirical analysis, it is necessary to analyze the correlation between the input and the output index, respectively. This paper uses the SPSS statistical software to conduct the Kaiser-Meyer-Olkin measure of sampling adequacy and the Bartlett sphere test. It can be seen from Table2 and Table3 that the KMO test statistics of the input and output index are 0.619 and 0.389. The correlation between the indexes is not strong. The approximate chi-square values of the Bartlett sphere test are 23.682 and 13.847, respectively, the chi-square value is not large. The probability values are 0.008 and 0.031, respectively, if the probability value is bigger than the given significance level of 0.001, then the null hypothesis is not rejected, and the variables are not considered to have significant correlation. In summary, the linear correlation between the input and output indexes of this study is not strong. They can be directly applied to empirical analysis of educational efficiency for higher normal universities.

TABLE 2. KMO AND BARTLETT TEST RESULTS OF INPUT INDEX

Sampling enough Kaiser-Meyer-Olkin metrics	0.619
Approximate chi-square	23.682
Bartlett's sphericity test df	10
Sig.	0.008

TABLE 3. KMO AND BARTLETT TEST RESULTS OF OUTPUT INDEX

Sampling enough Kaiser-Meyer-Olkin metrics	0.389
Approximate chi-square	13.847
Bartlett's sphericity test df	6
Sig.	0.031

C. Analysis of Efficiency Results

This study is from the angle of input, i.e how to minimize inputs under the premise of constant outputs. We apply the CCR and BCC models to evaluate educational efficiency of higher normal universities and use DEAP2.1 software to conduct the operation. Detailed results are shown in Table 4.

TABLE4. UNDERGRADUATE EDUCATION EFFICIENCY OF 31 HIGHER NORMAL UNIVERSITIES IN CHINA

DMU	crste	vrste	scale	e	DMU	crste	vrste	scale	e
1	1.000	1.000	1.000	-	17	1.000	1.000	1.000	-
2	1.000	1.000	1.000	-	18	1.000	1.000	1.000	-
3	0.993	1.000	0.993	drs	19	0.943	0.946	0.997	irs
4	1.000	1.000	1.000	-	20	0.920	1.000	0.920	drs
5	0.960	1.000	0.960	drs	21	1.000	1.000	1.000	-
6	1.000	1.000	1.000	-	22	0.977	0.997	0.981	drs
7	0.999	1.000	0.999	drs	23	0.880	1.000	0.880	irs
8	0.995	1.000	0.995	drs	24	1.000	1.000	1.000	-
9	0.934	0.951	0.982	drs	25	0.868	0.936	0.927	drs
10	1.000	1.000	1.000	-	26	1.000	1.000	1.000	-
11	0.905	1.000	0.905	drs	27	1.000	1.000	1.000	-
12	0.911	1.000	0.911	drs	28	1.000	1.000	1.000	-
13	1.000	1.000	1.000	-	29	1.000	1.000	1.000	-
14	0.876	1.000	0.876	drs	30	1.000	1.000	1.000	-
15	0.839	0.841	0.998	irs	31	1.000	1.000	1.000	-
16	0.940	0.944	0.996	drs	mean	0.966	0.988	0.978	-

note: crste represents the technical efficiency under the precise of constant returns to scale; vrste represents the pure technical efficiency under the precise of variable returns to scale; scale is the scale efficiency, and irs, -, drs separately represent the increasing, constant and decreasing returns to scale.

1) Technical Efficiency Analysis

Education performance of normal universities can be analysed by technical efficiency as the degree to which an education system achieve desired goals and effects. We conclude the distribution of technical efficiency values of 31 research samples, as shown in Table5. Among them, more than half of the higher normal universities have a technical efficiency value of 1, which means DEA effective; more than two-thirds of normal universities have technical efficiency values above 0.9, and it means utilization rate of these normal universities is relatively high; there are also a few universities with technical efficiency values between 0.8 and 0.9, which means they require timely adjustment of school running.

TABLE 5. THE DISTRIBUTION OF TECHNICAL EFFICIENCY VALUES OF 31 NORMAL UNIVERSITIES

crste	the number of DMU	percentage
1	16	51.6%
0.9-1	11	35.5%
0.8-0.9	4	12.9%
below 0.8	0	0%
sum	31	100.0%

Among 31 selected samples, there are 16 universities with technical efficiency of 1, namely Beijing Normal University, East China Normal University, Central China Normal University, Southwest University, Shandong Normal University, Anhui Normal University, Guizhou Normal University, Chongqing Normal University, Shanxi Normal University, Harbin Normal University, Qinghai Normal University, Liaoning Normal University, Hainan Normal University, Changchun Normal University, Qufu Normal University, and Minnan Normal University. Their technical efficiency values are the best of 31 higher normal universities. This means, they are DEA efficient. The other 15 higher normal universities are weakly DEA efficient. Among them, Yunnan Normal University, Jiangsu Normal University, Xinjiang Normal University, and Hangzhou Normal University have relatively lower technical efficiency values, all of which are less than 0.9. Jiangsu Normal University has the lowest technical efficiency of 0.839. However, in general, the average value of technical efficiency is 0.966 and more than half of technical efficiency values are efficient, indicating that the undergraduate education in China's higher normal universities has not serious waste of resources.

2) Pure Technical Efficiency Analysis

According to the calculated data, among 31 selected higher normal universities, 25 normal universities' pure technical efficiency values are 1. Nanjing Normal University, Jiangsu Normal University, Shanghai Normal University, Hebei Normal University, Guangxi Normal University, and Hangzhou Normal University are all pure technical inefficiency. Among them, the lowest pure technical efficiency is Jiangsu Normal University, which is 0.841. The allocation of its internal resources is incompatible with the school's management. On the whole, the average value of pure technical efficiency of 31 higher normal universities is 0.988, which is higher than the average value of technical efficiency. It indicates that undergraduate education in higher normal universities in China is in a good stage of resource allocation, and the internal configuration structure is reasonable. However, it is necessary to make better use of available resources and to make reasonable control of the inputs and outputs based on the actual situation so as to achieve DEA efficient.

D. Scale Efficiency and Return to Scale Analysis

Scale efficiency is the ratio of technical efficiency to pure technical efficiency. The scale efficiency is smaller than 1, indicating that the decision making unit is inefficient, i.e. increasing returns to scale or decreasing returns to scale. The closer the value is to 1, the more appropriate scale of the decision making unit is. If the scale efficiency value is equal to 1, it indicates that the decision making unit is in status of constant returns to scale, which is optimal.

We analyze the distribution of scale efficiency values of 31 research samples. It can be seen from Table 6 that scale efficiency values of higher normal universities are high on the whole. More than half of the normal universities' scale

efficiency values are 1, and the scale efficiency value which is between 0.9-1 accounts for 41% of the total number of samples. There is no normal university with the scale efficiency value below 0.8.

TABLE 6. THE DISTRIBUTION OF SCALE EFFICIENCY VALUES OF 31 NORMAL UNIVERSITIES

scale efficiency	the number of DMU	percentage
1	16	51.6%
0.9-1	13	41.9%
0.8-0.9	2	6.5%
below 0.8	0	0%
sum	31	100.0%

About the 31 research samples, 12 universities are in status of decreasing returns to scale, namely Northeast Normal University, Shaanxi Normal University, South China Normal University, Hunan Normal University, Nanjing Normal University, Fujian Normal University, Jiangxi Normal University, Yunnan Normal University, Shanghai Normal University, Henan Normal University, Guangxi Normal University, Hangzhou Normal University. For these 12 universities, the proportion of the increase in output will be less than the proportion of the increase in input, and the model of blindly increasing educational resources to expand educational outputs should be avoided. At the same time, it is also necessary to allocate and use the existing educational resources more efficiently. There are 3 higher normal universities in status of increasing returns to scale, namely Jiangsu Normal University, Hebei Normal University, and Xinjiang Normal University. For these 3 universities, the educational resources should be increased in the process of school running to obtain more output fruits.

Moreover, according to the calculated data, values of 9 normal universities' scale efficiency are less than 1 but values of pure technical efficiency are equal to 1. These universities are in inefficient status of increasing or decreasing returns to scale, while pure technical efficiency values are equal to 1, which means the resource allocation is already optimal, but the input and output do not match, and can not achieve constrain expansion. Among them, Xinjiang Normal University is in status of increasing returns to scale. It should maintain the current resource allocation model and increase investment to expand outputs. Other 8 normal universities are in status of decreasing returns to scale. They should control the investment in education and maximize the resource utilization under premise of maintaining the mode of resource allocation.

For normal universities with values of pure technical efficiency and scale efficiency are all less than 1, namely Nanjing Normal University, Jiangsu Normal University, Shanghai Normal University, Hebei Normal University, Guangxi Normal University, and Hangzhou Normal University, if these 6 universities want to achieve DEA efficient, the improvement should be made on the internal adjustment of structure. At the same time, the scale of school inputs should be appropriately increased or

decreased based on actual situation.

E. Efficiency Improvement Analysis

In order to analyze the detailed information about DEA inefficient, this paper uses projection analysis to calculate the values of insufficient output and input redundancy of every decision making unit, as shown in Table 7 and Table 8, respectively.

TABLE 7. INSUFFICIENT OUTPUTS OF 31 NORMAL UNIVERSITIES

DMU	Y1	Y2	Y3	Y4	DMU	Y1	Y2	Y3	Y4
1	0.00	0.00	0.00	0.00	17	0.00	0.00	0.00	0.00
2	0.00	0.00	0.00	0.00	18	0.00	0.00	0.00	0.00
3	0.00	0.00	0.00	0.00	19	0.00	0.12	0.00	0.01
4	0.00	0.00	0.00	0.00	20	0.00	0.00	0.00	0.00
5	0.00	0.00	0.00	0.00	21	0.00	0.00	0.00	0.00
6	0.00	0.00	0.00	0.00	22	0.00	0.10	0.04	0.00
7	0.00	0.00	0.00	0.00	23	0.00	0.00	0.00	0.00
8	0.00	0.00	0.00	0.00	24	0.00	0.00	0.00	0.00
9	4376.84	0.00	0.00	0.00	25	4099.05	0.00	0.03	0.00
10	0.00	0.00	0.00	0.00	26	0.00	0.00	0.00	0.00
11	0.00	0.00	0.00	0.00	27	0.00	0.00	0.00	0.00
12	0.00	0.00	0.00	0.00	28	0.00	0.00	0.00	0.00
13	0.00	0.00	0.00	0.00	29	0.00	0.00	0.00	0.00
14	0.00	0.00	0.00	0.00	30	0.00	0.00	0.00	0.00
15	4419.98	0.02	0.00	0.05	31	0.00	0.00	0.00	0.00
16	141.56	0.17	0.01	0.00					

TABLE 8. REDUNDANT INPUTS OF 31 NORMAL UNIVERSITIES

DMU	X1	X2	X3	X4	X5	DMU	X1	X2	X3	X4	X5
1	0.0	0.0	0.0	0.0	0.0	17	0.0	0.0	0.0	0.0	0.0
2	0.0	0.0	0.0	0.0	0.0	18	0.0	0.0	0.0	0.0	0.0
3	0.0	0.0	0.0	0.0	0.0	19	0.0	0.0	1068.7	0.0	13211.0
4	0.0	0.0	0.0	0.0	0.0	20	0.0	0.0	0.0	0.0	0.0
5	0.0	0.0	0.0	0.0	0.0	21	0.0	0.0	0.0	0.0	0.0
6	0.0	0.0	0.0	0.0	0.0	22	448.7	0.0	0.0	3.0	22406.0
7	0.0	0.0	0.0	0.0	0.0	23	0.0	0.0	0.0	0.0	0.0
8	0.0	0.0	0.0	0.0	0.0	24	0.0	0.0	0.0	0.0	0.0
9	249.4	0.0	0.0	2.8	17229.2	25	131.2	0.0	0.0	4.5	20886.2
10	0.0	0.0	0.0	0.0	0.0	26	0.0	0.0	0.0	0.0	0.0
11	0.0	0.0	0.0	0.0	0.0	27	0.0	0.0	0.0	0.0	0.0
12	0.0	0.0	0.0	0.0	0.0	28	0.0	0.0	0.0	0.0	0.0
13	0.0	0.0	0.0	0.0	0.0	29	0.0	0.0	0.0	0.0	0.0
14	0.0	0.0	0.0	0.0	0.0	30	0.0	0.0	0.0	0.0	0.0
15	0.0	0.0	659.9	0.0	13959.3	31	0.0	0.0	0.0	0.0	0.0
16	102.9	0.0	1688.9	0.0	0.0						

Based on the output index system constructed in the previous section, it can be seen from Table7 that the number of undergraduate students in Nanjing Normal University requires to increase 4376.84 in order to achieve DEA efficient. Jiangsu Normal University, Shanghai Normal University, Hebei Normal University, Guangxi Normal University, and Hangzhou Normal University, these five universities are all have the problem of insufficient outputs, that is, the difference between existing outputs and the optimal outputs under premise of constant inputs. Among them, the difference about the number of undergraduate students of Jiangsu Normal University and Hangzhou Normal University are the most obvious.

According to the previous input index system, it can be seen from Table8 that Nanjing Normal University, Guangxi Normal University and Hangzhou Normal University all exist large redundant inputs in three aspects of full-time teachers, per capita teaching administrative room area, and the total value of teaching and research equipment assets. Undergraduate students' teaching expenditure and the total value of teaching and research equipment assets have the most significant influence on educational efficiency of Jiangsu Normal University and Hebei Normal University. There are redundancy problems in both aspects of the number of full-time teachers and undergraduate students' teaching expenditure of Shanghai Normal University. The redundant teaching expenditures for undergraduate students are the highest among 31 normal universities. In the process of running schools, the investment in this aspect should be properly controlled.

F. Sensitivity Analysis of Indexes

In this paper, five input indexes and four output indexes are selected for the evaluation index system. According to the results of educational evaluation, we can know that comprehensive effects of multiple indexes affect values of DEA efficiency. For the inefficient decision making unit, it is of great significance to find the index that has the largest influence on the value of educational evaluation.

Based on the average efficiency value of combined schemes of the input and output index system, this paper finds the input and output indexes that have the greatest influence on educational efficiency. The number of input and output indexes in this paper is 9. Considering that there are too many combined schemes, this paper finally selects the combined schemes excluding a single index for comparative analysis. We use DEAP 2.1 software to conduct the calculation, and the results are shown in Table 9.

TABLE 9. THE AVERAGE VALUE OF DEA EFFICIENCY UNDER DIFFERENT INDEXES SYSTEM

schemes	combined indexes system	the mean of technical efficiency	the mean of pure technical efficiency	the mean of scale efficiency
1	X1+X3+X4+X5	0.868	0.962	0.901
2	X1+X2+X4+X5	0.951	0.977	0.974
3	X1+X2+X3+X5	0.957	0.987	0.970
4	X1+X2+X3+X4	0.958	0.980	0.977
5	X2+X3+X4+X5	0.960	0.982	0.978
6	Y1+Y3+Y4	0.962	0.985	0.976
7	Y1+Y2+Y4	0.955	0.978	0.977
8	Y1+Y2+Y3	0.955	0.977	0.977
9	Y2+Y3+Y4	0.959	0.981	0.977

In order to measure the influence level of combined indexes system, this paper uses D to represent different schemes. $V(D)$ represents the average value of technical efficiency under all evaluation index set, i.e. the average technical efficiency value of undergraduate education in 31 higher normal universities. We use D' to represent the

index set after the i -th index is removed from the initial evaluation index set, then $V(D')$ means the average technical efficiency value after the i -th index is removed. Accordingly, the influence level of index i can be calculated by the following formula:

$$S_i = \frac{V(D) - V(D')}{V(D')}, i = 1, 2, \dots, m \quad (3)$$

Combined with the related data in previous section, the influence values of S_{X2} , S_{X3} , S_{X4} , S_{X5} , S_{X1} , S_{Y2} , S_{Y3} , S_{Y4} and S_{Y1} on DEA efficiency are 0.113, 0.016, 0.009, 0.008, 0.006, 0.004, 0.012, 0.012, and 0.007, respectively.

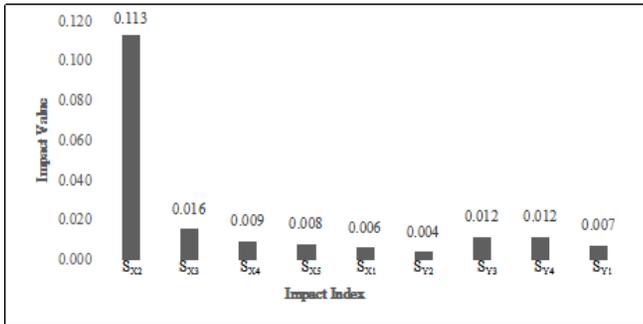


Fig. 1. The Influence Value of Different Indexes

It can be seen from Fig.1 that about the input index system, the proportion of associate and full professors giving lessons for undergraduates has the greatest influence on DEA efficiency, followed by the index of average undergraduate students' teaching expenditure. We can also know that from the angle of investment, teaching quality and teaching funds have the most significant influence on educational efficiency. About the output index system, the degree-conferring rate and graduates' employment rate have the most significant influence on the promotion of educational efficiency, thus pushing forward the work of graduates' employment and improving the degree-conferring rate to improve educational efficiency of normal universities are of great significance.

IV. CONCLUSIONS AND SUGGESTIONS

In this paper, DEA models are used to evaluate the efficiency of 31 higher normal universities in China, and detailed problems of insufficient outputs and redundant inputs are analyzed, then key indexes affecting educational efficiency of normal universities are identified through the index sensitivity analysis. The main conclusions of this paper are as follows:

First, on the whole, the undergraduate education of China's normal universities has high resource utilization, and the allocation of resources is in an excellent status with a reasonable internal allocation structure. The average value of technical efficiency is lower than that of pure technical efficiency, which is mainly due to the scale inefficiency of normal universities. Therefore, in order to improve the efficiency of undergraduate education in China's higher

normal universities, the government and normal universities themselves should properly increase or reduce the inputs in combination with the actual situation of running schools, and reasonably allocate the existing resources to achieve scale efficiency.

Second, the analysis of undergraduate education efficiency of China's normal universities is mainly based on 31 research samples, among which 6 universities are directly under the Ministry of Education and 25 are provincial normal universities. According to the analysis results, 4 of the 6 normal universities which are directly under the Ministry of Education are technical efficiency, and 12 of the 25 provincial normal universities are DEA efficient, accounting for nearly 50%. Thus it can be known that the attributes of normal universities cannot directly determine whether the efficiency is efficient or not. Therefore, normal universities themselves should undertake the main responsibility for improving the efficiency of undergraduate education.

Third, different indexes systems may affect the educational efficiency differently. In the DEA efficiency analysis of this paper, we find three indexes that have the most significant influence on educational efficiency of normal universities. From the angle of investment, to improve educational efficiency, it is necessary to increase the input of teachers, strengthen the construction of teaching staff, and attach more importance to the improvement of teaching quality in undergraduate education of normal universities. In regard to the outputs, China's normal universities should actively enhance the service ability, strengthen the guidance work of employment, and actively promote the employment of undergraduate graduates.

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